Keysight U9400A/C Solid State FET Transfer Switches

Operating and Service Manual

KEYSIGHT TECHNOLOGIES

Notices

Manual Part Number

U9400-90001

Edition

Edition 2, August 2014

Printed in Malaysia

Keysight Technologies
Phase 3 Bayan Lepas Free Industrial Zone
Bayan Lepas, Penang 11900 Malaysia

Warranty

The material contained in this document is provided "as is," and is subject to being changed, without notice, in future editions. Further, to the maximum extent permitted by applicable law, Keysight disclaims all warranties, either express or implied, with regard to this manual and any information contained herein, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Keysight shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, use, or performance of this document or of any information contained herein. Should Keysight and the user have a separate written agreement with warranty terms covering the material in this document that conflict with these terms, the warranty terms in the separate agreement shall control.

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

Restricted Rights Legend

U.S. Government Restricted Rights. Software and technical data rights granted to the federal government include only those rights customarily provided to end user customers. Keysight provides this customary commercial license in Software and technical data pursuant to FAR 12.211 (Technical Data) and 12.212 (Computer Software) and, for the Department of Defense, DFARS 252.227-7015 (Technical Data - Commercial Items) and DFARS 227.7202-3 (Rights in Commercial Computer Software or Computer Software Documentation).

Safety Notices

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Certification

Keysight Technologies certifies that this product met its published specifications at the time of shipment from the factory. Keysight Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (NIST, formerly NBS), to the extend allowed by the Institute's calibration facility, and to the calibration facilities of the other International Standards Organization members.

WEEE Compliance

This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a "Monitoring and Control Instrumentation" product.

Do not dispose in domestic household waste.

To return unwanted products, contact your local Keysight office, or see www.keysight.com for more information.

Contacting Keysight

For more information, please contact your nearest Keysight office.

Americas	
Canada	(877) 894-4414
Latin America	305 269 7500
United States	(800) 829-4444
Asia Pacific	
Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	81 426 56 7832
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Thailand	1 800 226 008
Europe	
Austria	0820 87 44 11
Belgium	32 (0) 2 404 93 40
Denmark	45 70 13 15 15
Finland	358 (0) 10 855 2100
France	0825 010 700
Germany	01805 24 6333
Ireland	1890 924 204
Italy	39 02 92 60 8484
Netherlands	31 (0) 20 547 2111
Spain	34 (91) 631 3300
Sweden	0200-88 22 55
Switzerland(French)	41 (21) 8113811 (Opt 2)
Switzerland(German)	0800 80 53 53 (Opt 1)
United Kingdom	44 (0) 118 9276201
Other European Countries:	www.keysight.com/find/contactus

Or, go to www.keysight.com/find/assist for more information.

Contents

1 Introduction 7

Product Overview 8

Features 9

Circuit Logic 10

Specifications 12

2 Environmental Specifications & Physical Dimensions 15

Environmental Specifications 16

Physical Dimensions 17

U9400A/C Dimensions 17

3 Operating Guides 19

Installation 20

Initial Inspection 20

Operating Instruction 21

Operator's Check 21

Performance Tests 23

Service Instructions 23

1
Introduction

Product Overview 8
"Features"
Circuit Logic 10
Specifications 12

This chapter provides an overview specifications of Keysight solid state FET transfer switches.

Product Overview

Keysight U9400A/C consist of 8/18 GHz solid state FET transfer switches which are developed based on GaAs FET Monolithic Microwave Integrated Circuit (MMIC). These solid state switches provide high isolation; low video leakage; superior insertion loss and return loss across a broad operating frequency range.

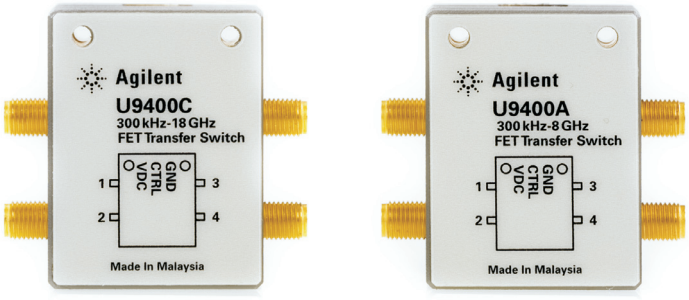


Figure 1 U9400C and U9400A Solid State FET Transfer Switches

Table 1 List of Solid State FET Transfer Switches

Keysight Model Number	Frequency Range	Connector Type
U9400A	300 kHz to 8 GHz	SMA (f)
U9400C	300 kHz to 18 GHz	SMA (f)

Keysight U9400A/C solid state FET transfer switches are designed to protect and preserve user's network components and devices under test (DUTs) by offering minimal video leakage. Furthermore, U9400A/C switches are particularly suitable for measuring sensitive devices and components such as mixers and amplifiers; where high video leakage might damage or cause reliability issues to user's devices. Extraordinary settling time of 350 µs as well as exceptional switching speed of 500 ns make these switches ideal for ultra fast RF and microwave switching applications in instrumentation, communication, radar, switch matrixes and various other test systems.

Features

- Minimize crosstalk with exceptionally high port to port isolation of > 100 dB at 8 GHz
- Increase test setup flexibility with a broad operating frequency range (300 kHz to 18 GHz)
- Prevent damage to sensitive devices or components with low video leakage of typically < 5 mVpp
- Maintain fast throughput with industry leading settling time for FET switches of 350 µs
- Eliminate the need for external drivers with integrated TTL–compatible driver

Circuit Logic

Keysight U9400A/C switches come with integrated TTL–compatible driver that is configured in such a way that when a TTL high (logic 1) is applied to CTRL pin of the switch, the paths from Port 1 to Port 2 and port 3 to Port 4 of the switch are at high isolation, while the paths from Port 1 to Port 3 and Port 2 to Port 4 are at low loss. When TTL low (logic 0) is applied to CTRL pin of the switch, the paths from Port 1 to Port 3 and Port 2 to Port 4 of the switch are at high isolation while the paths from Port 1 to Port 2 and Port 3 to Port 4 are at low loss.

Table 2 Switch Operation Logic

CTRL Logic	State	Port 1 to Port 2 Port 3 to Port 4	Port 1 to Port 3 Port 2 to Port 4
TTL high	A	High Isolation	Low Loss
TTL low	B	Low Loss	High Isolation

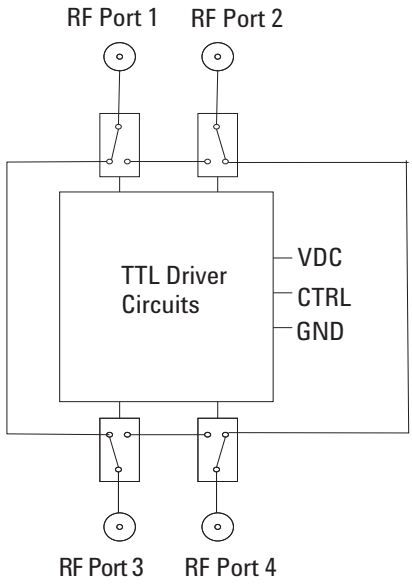


Figure 2 Diagram of U9400A/C Switches in State A

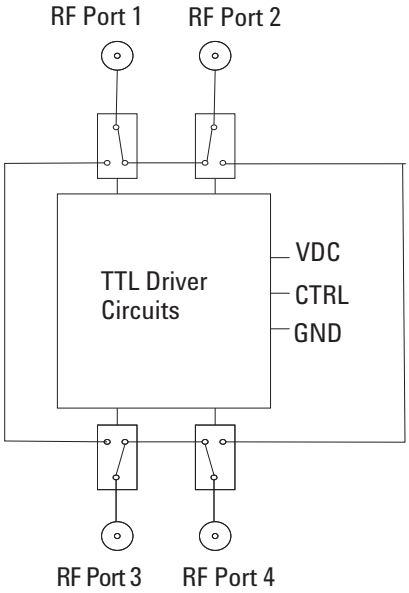


Figure 3 Diagram of U9400A/C Switches in State B

Specifications

Specifications refer to the performance standards or limits against which the solid state FET transfer switches are tested.

Typical characteristics are included for additional information only and they are not specifications. These are denoted as "typical", "nominal" or "approximate" and are printed in italics.

Table 3 U9400A/C Solid State FET Transfer Switches

Keysight Model Number	U9400A	U9400C
Frequency range	300 kHz to 8 GHz	300 kHz to 18 GHz
Insertion loss	< 3.0 dB (300 kHz to 4 GHz) < 3.5 dB (4 GHz to 8 GHz)	< 5.0 dB (300 kHz to 8 GHz) < 6.5 dB (8 GHz to 18 GHz)
Isolation	> 100 dB	> 90 dB
Return loss (ON Ports)	> 15 dB	> 10 dB
*Switching speed (ON/OFF time)**	*4 µs /0.5 µs (typical)*	*5 µs /1 µs (typical)*
Settling time	*< 350 µs (typical)*	*< 350 µs (typical)*
Video leakage	*< 5 mVpp (typical)*	*< 5 mVpp (typical)*
Characteristic Impedance	*50 Ω (nominal)*	*50 Ω (nominal)*
Connectors	SMA (f)	SMA (f)

* Switching speed is based on 50% TTL to 90% RF (ON time) or 50% TTL to 10% RF (OFF time)

Table 4 Absolute Maximum Ratings of U9400A/C*

Parameters	Min	Max
RF input power (average)	–	+ 29 dBm (U9400A) + 27 dBm (U9400C)
VDC	+ 11 V	+ 26 V
Control Input High Voltage	+ 2.4 V	+ 5 V
Control Input Low Voltage	0 V	+ 0.8 V
Current sourcing at RF1 or RF2†	–	60 mA

* Operation in excess of any one of these may result in permanent damage to the products

† Sinking not allowed

1 Introduction

2
Environmental Specifications & Physical Dimensions

Environmental Specifications 16
Physical Dimensions 17
"U9400A/C Dimensions"

This chapter contains the environmental tests on the U9400A/C that fully comply with Keysight Technologies' product operating environmental specifications. The physical dimensions are illustrated in the later section.

Environmental Specifications

Keysight U9400A/C solid state FET transfer switches are designed to fully comply with Keysight Technologies' product operating environmental specifications as shown in Table 5.

Table 5 U9400A/C Solid State FET Transfer Switches Environmental Specifications

Temperature:	
• Operating	-40 ° C to +85 ° C
• Storage	-65 ° C to +125 ° C
• Cycling	-65° C to +150 ° C, 10 cycles @ 20 ° C per minute ramp rate, 20 minutes dwell time per MIL-STD-833F, Method 1010.8, Condition C (modified)
Humidity:	
• Operating	50% to 95% RH @ 40 ° C, one 24 hour cycle, repeated 5 times
• Storage	<90% RH at 65 ° C, 24 hours
Shock:	
• Half sine, smoothed	1000 G @ 0.5 ms, 3 shock pulses per orientation, 18 total per MIL-STD-833F, Method 2002.4, Condition B (modified)
Vibration:	
• Broadband random	50 to 2000 Hz, 7.0 G rms, 15 minutes, per MIL-STD-833F, Method 2026-1 (modified)
Altitude:	
• Storage	< 15, 300 meters (50,000 feet)
ESD immunity:	
• Direct discharge*	1.0 kV per IEC 61000-4-2
• Air discharge†	2.5 kV per IEC 61000-4-2

* To outer conductor

† To center conductor

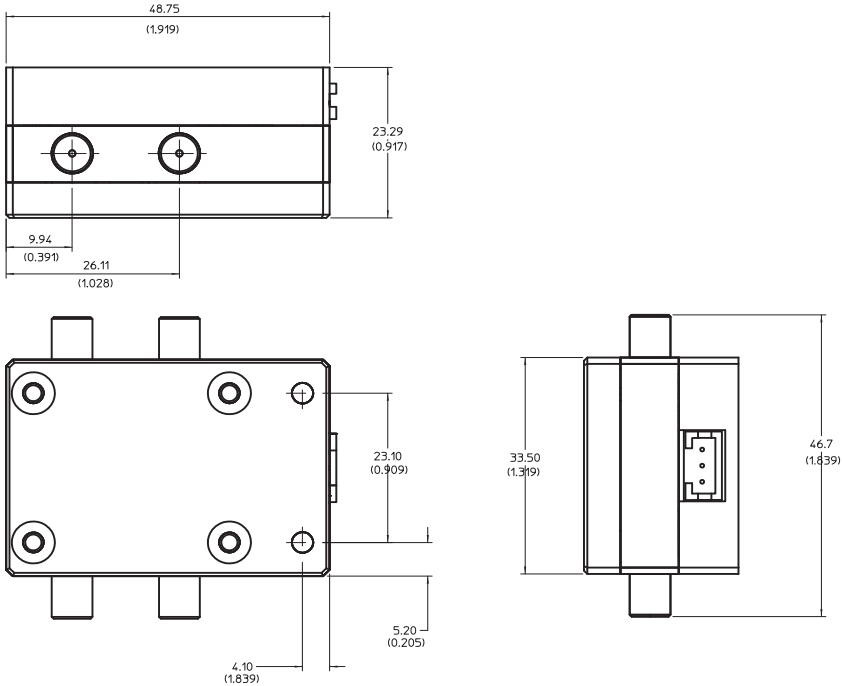
Physical Dimensions

Table 6 illustrates the physical dimensions of U9400A/C solid state FET transfer switches.

U9400A/C Dimensions

Table 6 U9400A/C Solid State FET Transfer Switches Physical Dimensions

Dimensions	Per Figure 4
Net weight, kg (lb)	0.095 (0.209)



Dimensions in millimetres (inches)

Figure 4 Dimensions of U9400A/C Solid State FET Transfer Switches

3
Operating Guides

Installation 20
"Initial Inspection"
Operating Instruction 21
"Operator's Check"
Performance Tests 23

This chapter describes the installation of the U9400A/C. The operating instruction quick- check procedure is included for verification test prior to usage. Service instructions on the repair and maintenance of the U9400A/C are also included in this chapter.

Installation

Initial Inspection

1. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked both mechanically and electrically.
   - Check for mechanical damage such as scratches or dents.
   - Procedures for checking electrical performance are given under “Operator’s Check” or “ Performance Tests”.
2. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance test, contact the nearest Keysight Technologies Sales and Service office. Refer to the Service and Support information in the front matter of this manual. Keysight Technologies will arrange for repair or replacement of the damaged or defective equipment. Keep the shipping materials for the carrier’s inspection.
3. If you are returning the instrument under warranty or for service, repackaging the instrument requires original shipping containers and materials or their equivalents. Keysight Technologies can provide packaging materials identical to the original materials. Refer to Service and Support information in the front matter of this manual for the Keysight Technologies nearest to you. Attach a tag indicating the type of service required, return address, model number and serial number. Mark the container ***FRAGILE*** to insure careful handling. In any correspondence, refer to the instrument by model number and serial number.

Operating Instruction

Operator's Check

The operator's check is supplied to allow the operator to make quick–check of the switches prior to use or if a failure is suspected.

CAUTION ESD exceeding the level specified in Table 5 or RF power applied is greater than the maximum specified as in Table 4 may cause permanent damage to the device.

Description

The solid state FET transfer switch is connected to a network analyzer configured for the s–parameter measurement. The network analyzer may be set to sweep over the whole or selected frequency range of the solid state FET transfer switch to be verified. The s–parameter measurements are required to determine if the switch is working properly by applying the appropriate logic to the CTRL pin.

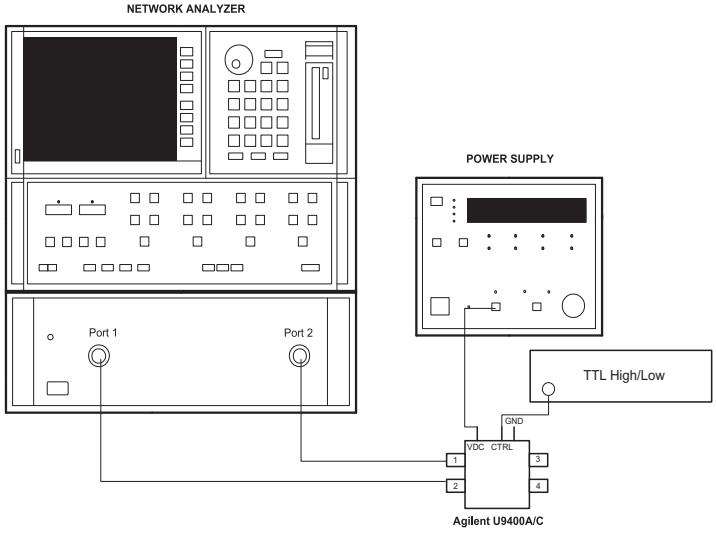


Figure 5 Quick-check Configuration for U9400A/C

Quick-Check Procedure

1. Calibrate the network analyzer with full 2- port cal using the appropriate electronic/mechanical calibration kit.
2. Connect network analyzer's Port 1 and Port 2 to Port 1 and Port 2 of the switch respectively.
3. Turn ON Port 1 and Port 2 of the switch by applying logic '0' (0 V to +0.8 V) to CTRL. Then, measure S11and S22 (return loss) and S21 (insertion loss) and verify them against Table 3.
4. Repeat Step 2 and 3 for Port 3 and Port 4 of the switch.
5. Repeat Step 2 and 3 for Port 1 and Port 3 of the switch by applying logic '1' (+2.4 V to +5.0 V) to CTRL.
6. Repeat Step 2 and 3 for Port 2 and Port 4 of the switch by applying logic '1' (+2.4V to +5.0 V) to CTRL.

Performance Tests

The solid state FET transfer switches can be tested to the accuracy of the specifications with a network analyzer or equivalent equipment of suitable accuracy. If a network analyzer is available, test instrument using the procedure in the analyzer's operating manual.

Service Instructions

Adjustment

The solid state FET transfer switches do not have internal adjustments and should not be opened.

Repair

The U9400A/C solid state FET transfer switches are not recommended for repair as most components are not easily removed.

Maintenance

The connectors, particularly the connector faces, must be kept clean. For instruction on connecting and care of your connectors, refer to Microwave Connector Care Quick Reference Card (08510- 90360).

Edition 2, August 2014

U9400-90001
www.keysight.com

KEYSIGHT
TECHNOLOGIES